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(54) SCREW CONNECTION BETWEEN TUBULAR BARS AND ATTACHMENT CONNECTORS IN SPACE FRAMEWORKS

(57) A screw-threaded bolt 14 captive in the end of a tubular bar 11 can be screwed into a connector by means of a drive sleeve comprising a hub 18 connected by spokes 19 to a cylinder 20. The cylinder 20 is clamped between a flat 27 on the connector and an end face 26 of a connection portion 12 welded to the bar 11 and having the same outer diameter as the bar 11. The cylinder 20 has an outside diameter the same or greater than that of the bar 11 in order to facilitate operation by a motor-driven screwing tool and provide resistance to bending and twisting forces.

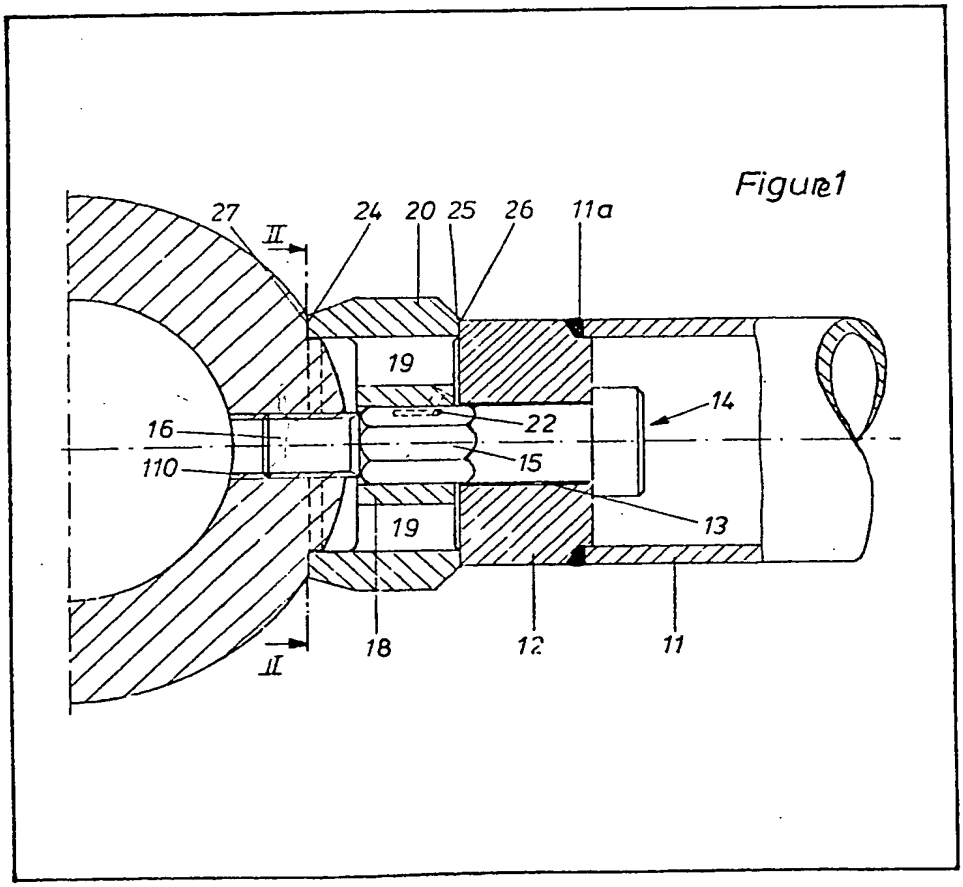

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Figure1

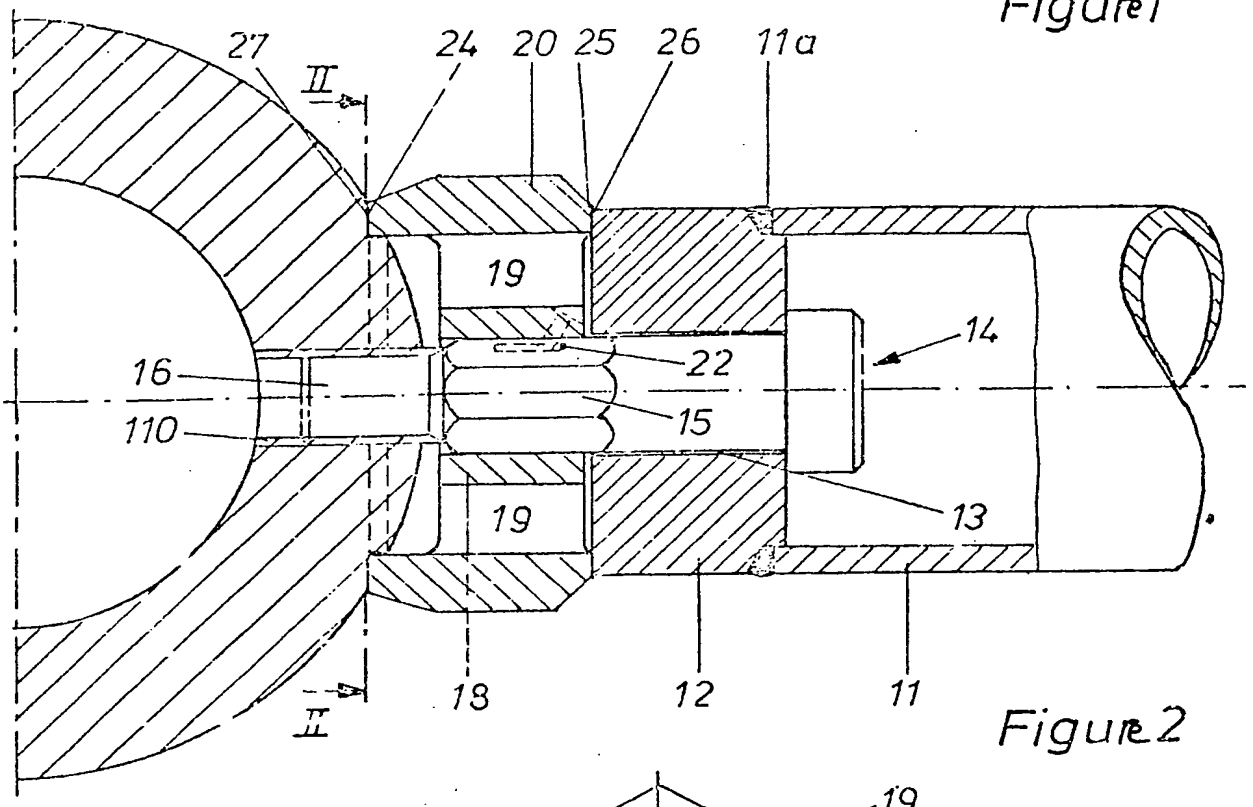


Figure2

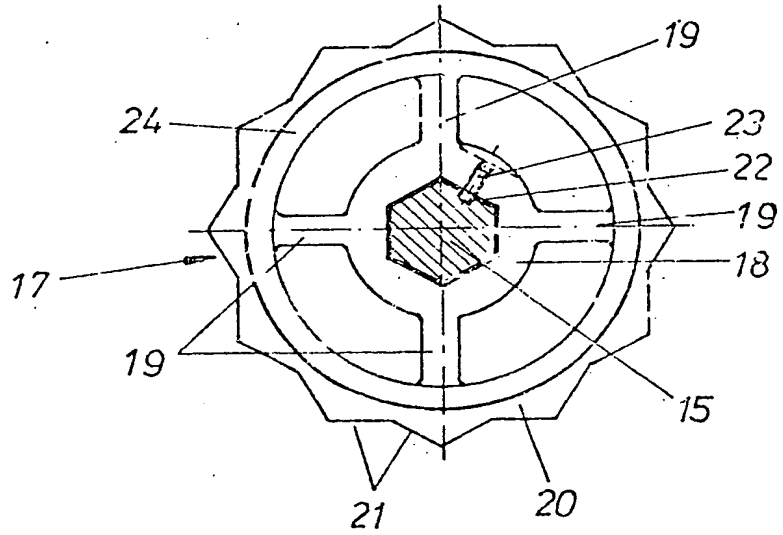
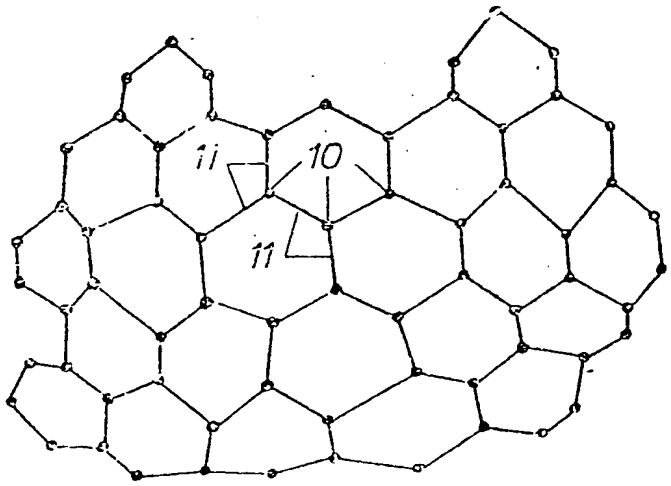


Figure3



SPECIFICATION

SCREW CONNECTION BETWEEN TUBULAR BARS AND ATTACHMENT CONNECTORS IN SPACE FRAMEWORKS

The invention relates to a screw connection between tubular bars and attachment connectors in space frameworks, having a screw-threaded bolt which is carried in the ends of each tubular bar for rotary movement and for limited axial movement, and having a drive sleeve member which is arranged on the screw-threaded bolt so as to be non-rotatable but capable of limited axial movement, by means of which drive sleeve member the screw-threaded bolt can be screwed in one of the screw-threaded holes in an attachment connector, wherein the drive sleeve member can be clamped between a respective flat portion on the attachment connector and the end face of connection portions at the ends of the tubular bars.

Such a screw connection is known for example from German patent specification No. 901 955. In order on the one hand to make it possible to use relatively small attachment connectors, and on the other hand to provide the possibility of connecting numerous tubular bars to such connectors, in this known construction the connection portions at the ends of the tubular bars are formed by portions which are tapered to form truncated cones or truncated pyramids, while the contact faces at the ends of the drive sleeve members are of correspondingly relatively small diameter. Because the ends of the bars are tapered and because the drive sleeve members are adapted thereto in respect of their diameter, such a screw connection can only carry relatively low bending forces however, so that such a connection is not suitable for example for single-shell space frameworks or single-shell domes as, besides the usual traction and compression forces, such structures also experience quite considerable bending and twisting moments which must be carried by the screw connections between the tubular bars and the attachment connectors.

The above-mentioned disadvantages are also encountered in the screw connection between tubular bars and coupling members, as is known from German patent specification No. 912 145, in which drive sleeve members with contact surfaces of relatively large diameter are in fact used, but the ends of the tubular bars are of a conically tapered construction, as already mentioned above. Also, the tapered reinforcing sleeves which are arranged over the ends of the tubular bars cannot increase the bending strength of this known screw connection in a manner such that it would be suitable for single-shell space frameworks. Added to this is the fact that the above-mentioned reinforcement sleeves take up an additional amount of space and make it virtually impossible to apply motor-driven screwing tools from the side; however, such motor-driven tools are required for tightening high-strength bending-resistant screw connections for for example space framework domes.

It is also known from DOS No. 2 246 478, in space frameworks, for the tubular bars to be connected to spherical attachment connectors, over the full outside bar diameter, that is to say, without any taper. However, this known construction is so designed that a respective screw-threaded bolt is welded by its head into one end of a tubular bar, while the screw-threaded bolt in the other end of the tubular bar is biassed outwardly for example by a compression spring, and must be tightened by means of a screwdriver. Such a screw connection is however completely unsatisfactory for single-shell space frameworks. As moreover the end faces of the tubular bars are bevelled inwardly, so that they seat positively on the spherical periphery of the attachment connector, bending forces at the ends of the bars are transmitted to the attachment connector only by way of the screw-threaded bolts. In other words, the tubular bars are secured to the spherical periphery of the attachment connectors by the screw-threaded bolts, in the manner of a ball-and-socket joint.

The invention is based on the problem of providing a high-strength screw connection between tubular bars and attachment connectors in space frameworks, which connection, besides carrying traction and compression forces, can also carry extremely high bending and twisting forces, as occur for example in single-shell large-size space frameworks. The screw connection is also to be such that it can be easily tightened and released by means of motor-driven screwing tools.

In accordance with the invention, in a screw connection of the kind indicated above, this problem is solved in that the outside diameter of the tubular bars, which is constant over the whole tubular bar length, is continued at a uniform value by way of the connection portions at the ends of the tubular bars, as far as the end faces on the connection portions, which end faces are provided for bearing against a respective drive sleeve member, and that the smallest outside diameter of the drive sleeve members is equal to or greater than that of the tubular bars and their connection portions. When such a screw connection is tightened, the respective bar end with the connection portion and the drive sleeve member virtually forms a component of the same or substantially the same outside diameter which at best becomes larger towards the attachment connector, so that even extremely high bending moments at the attachment connector can be satisfactorily absorbed. As the smallest outside diameter of a drive sleeve member is equal to or greater than that of the tubular bars and their connection portions, a motor-driven screwing tool can be easily applied to the drive sleeve member from the side, in order to apply to the screw-threaded bolt the torque required for making the high-strength screw connection. The finished screw connection is also capable of

transmitting considerable torsional forces from a tubular bar to an attachment connector and vice-versa, as well as the usual traction and compression forces.

It is possible for the drive sleeve member to be of a construction which saves weight and which also facilitates the assembly operation, if in accordance with a further construction of the invention the drive sleeve member has a hub portion which is arranged on the screw-threaded bolt and which is connected by way of a plurality of spokes to a rim-like portion which carries the engagement surfaces for a screwing tool.

In accordance with a further feature of the invention, a simplification in instruction, with a corresponding reduction in manufacturing costs, is achieved by the hub portion being set back axially at both ends, with respect to the rim-like portion, by such a distance that the end faces of the rim-like portion form the contact faces of the drive sleeve member, which contact faces are of a circular ring configuration.

The machining cost for the attachment connector is further reduced and the economy of the screw connection is correspondingly increased, if in accordance with a further feature of the invention the flat portions on the attachment connectors, which form the contact faces for the drive sleeve members, are also of a circular ring configuration, corresponding to the associated contact faces of the drive sleeve members.

The invention is described hereinafter with reference to the drawing which shows an embodiment by way of example and in which:

Figure 1 shows a view in cross-section on a greatly reduced scale of the screw connection according to the invention, with a part of a tubular bar and an attachment connector,

Figure 2 shows an end view of the drive sleeve member as viewed in the direction of the arrows II—II in Figure 1, with the screw-threaded bolt being shown in section in the region of its hexagonal portion, and

Figure 3 shows a diagrammatic view of a portion of a single-shell space framework dome in which the screw connection according to the invention may be used.

The part of a space framework dome shown in Figure 3 shows that three tubular bars 11 are connected at different angles at each attachment connector 10, and that the individual screw connections between the tubular bars and the attachment connectors must carry traction, compression, bending and torsional forces.

Figure 1 shows a part of a hollow attachment connector 10 which has a radial screw-threaded hole 11 and which also has two further screw-threaded holes of this kind (not shown), as shown in the construction of Figure 3. Figure 1 also shows one end of a tubular bar 11 of round annular cross-section, to which a cylindrical connection portion 12 is welded by a ring weld 11a. The outside diameter of the cylindrical connection portion 12 corresponds to that of the tubular bar 11. The connection portion 12 is provided with a central longitudinal bore 13 through which a screw threaded bolt 14 extends with its hexagonal portion 15, so as to be rotatable and axially displaceable. Adjacent its hexagonal portion 15 the screw-threaded bolt 14 has a screw-threaded portion 16 which can be screwed into the screw-threaded hole 110 in the attachment connector 10, by means of a drive sleeve member 17.

In the embodiment illustrated, the drive sleeve member has a hub portion 18 which is connected by four spokes 19 to a rim-like portion 20. Engagement surfaces 21 for a preferably hydraulically or pneumatically operated screwing tool are provided on the outside periphery of the portion 20.

The internal cross-section of the hub portion 18 is closely adapted to the periphery of the hexagonal portion 15, in order to provide a non-rotatable connection between the screw-threaded bolt 14 and the drive sleeve member 17, while however permitting relative axial movement between the screw-threaded bolt and the drive sleeve member.

So that the drive sleeve member 17 is connected to the screw-threaded bolt 14 and thus to the tubular bar 11, in such a way that it cannot be lost, the screw-threaded bolt is provided at its hexagonal portion 15 with an axis-parallel longitudinal groove 22 into which engages the inner end of a setscrew 23 which is screwed into the hub portion 18. The length of the longitudinal groove 22 is sufficient to permit the longitudinal movement of the screw-threaded bolt 14 towards the attachment connector 10, which is required when the screw connection is tightened.

Figure 1 shows that the hub portion 18 including the spokes 19 is set back axially with respect to the rim-like portion 20. Consequently, only the annular end faces of the rim-like portion 20 form the contact faces 24 and 25 of the drive sleeve member; the outside diameters of the contact faces 24 and 25 are equal to each other, but slightly greater than the outside diameter of the connection portion 12 and the tubular bar 11. The contact face 25 co-operates with the end face 26 of the connection portion 12, which is formed normal to the axis of the tubular bar, while the contact face 24 of the drive sleeve member is seated on an annular contact face 27 on the attachment connector 10.

The screw connection shown in Figure 1 in accordance with the invention is tightened by turning the drive sleeve member 17 by means of a hydraulically or pneumatically operated screwing tool (not shown) of conventional kind, as already mentioned above, by means of which a tubular bar can be pre-stressed with considerable force against an attachment connector. In the case of a single-layer space framework dome whose largest diameter is about 60 metres, and which is formed by using tubular bars with for example an outside diameter of 127 mm and a wall thickness for example 10 mm, this pre-stressing force can be up

to 60 Mp for each screw connection, in order to transmit by way of the screw connection to an attachment connector, bending moments of up to 1.5 Mpm, torsional moments of up to 0.75 Mpm, and additional traction and compression forces of several Mp. As the engagement surfaces 21 are disposed radially outwardly of the periphery of the connection portion 12, the screwing tool can easily be applied repeatedly to the drive sleeve member from the side, when making the screw connection.

In the screw connection in the finished condition (Figure 1), the drive sleeve member 17 is firmly clamped by the screw-threaded bolt 14 between the end face 26 of the connection portion 12 and the contact face 27 on the attachment connector 10, while the lever arms, which are relatively large relative to the axis of the tubular bar, in the direction of the interengaged contact face 24 and contact face 27 on the attachment connector, make it possible to absorb even extremely high bending moments. This is further assisted by the feature that the faces 27 and 24 extend in a plane normal to the axis of the tubular bar.

CLAIMS

1. A screw connection between tubular bars and attachment connectors in space frameworks, having a screw-threaded bolt which is carried in the ends of each tubular bar for rotary movement and for limited axial movement, and having a drive sleeve member which is arranged on the screw-threaded bolt so as to be non-rotatable but capable of limited axial movement, by means of which drive sleeve member the screw-threaded bolt can be screwed in one of the screw-threaded holes in an attachment connector, wherein the drive sleeve member can be clamped between a respective flat portion on the attached connector and the end face of connection portions at the ends of the tubular bars, characterised in that the outside diameter of the tubular bars (11), which is constant over the whole tubular bar length, is continued at a uniform value by way of the connection portions (12) at the ends of the tubular bars, as far as the end faces (26) on the connection portions (12), which end faces are provided for bearing against a respective drive sleeve member (17), and that the smallest outside diameter of the drive sleeve members (17) is equal to or greater than that of the tubular bars (11) and their connection portions (12).

2. A screw connection according to claim 1 characterised in that the drive sleeve member has a hub portion (18) which is arranged on the screw-threaded bolt (14) and which is connected by way of a plurality of spokes (19) to a rim-like portion (20) which carries the engagement surfaces (21) for a screwing tool.

3. A screw connection according to claim 2 characterised in that the hub portion (18) is set back axially at both ends with respect to the rim-like portion (20) by such a distance that the end faces of the rim-like portion (20) form the contact faces (24, 25) of the drive sleeve member (17), which contact faces are of a circular ring configuration.

4. A screw connection according to claim 3 characterised in that the flat portions on the attachment connectors (10), which flat portions form the contact faces (27) for the drive sleeve members (17), are of a circular ring configuration corresponding to the associated contact face (24) of the drive sleeve members (17).

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